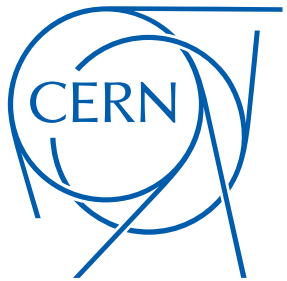
Benchmark cross sections: comparison with theory predictions

Marek Schönherr

LHC EW WG Meeting

21 Jun 2018



Aim

Assess compatibility of different inclusive jet, dijet and b-jet measurements at 7 TeV.

Use Monte-Carlo calculations as transfer function to compare consistency of different measurements.

$\Rightarrow$ **since different measurements use different fiducial phase space definitions, differences in description of different measurements may also stem from different levels of mismodelling in different phase space regions**

Tools – NLOPS for incl. jets and dijets

POWHEG+PYTHIA8

Alioli et.al. arXiv:1012.3380

- $\mu_{R/F} = p_{\mathrm{T}}^{j}$ (underlying Born)
- NNPDF 3.0 NNLO
  $\alpha_s(m_Z) = 0.118$
- generation cuts
  $p_{\mathrm{T}}^{j} > 15\,\mathrm{GeV}$
- PYTHIA:
  CUETp8M1 tune
  w/ NNPDF 2.1 LO

⇒ **generated by H. Jung**

SHERPA (S-MC@NLO)

Höche, MS arXiv:1208.2815

- $\mu_{R/F} = \frac{1}{2} H_{\mathrm{T}}$, $\mu_Q = \frac{1}{2} p_{\mathrm{T}}^{j}$
- NNPDF 3.0 NNLO
  $\alpha_s(m_Z) = 0.118$
- generation cuts
  $p_{\mathrm{T}}^{j} > 15\,\mathrm{GeV}$
- non-perturbative:
  default tune
  w/ NNPDF 3.0 NNLO

⇒ **generated by S. Kuttimalai**

Analyses

ATLAS

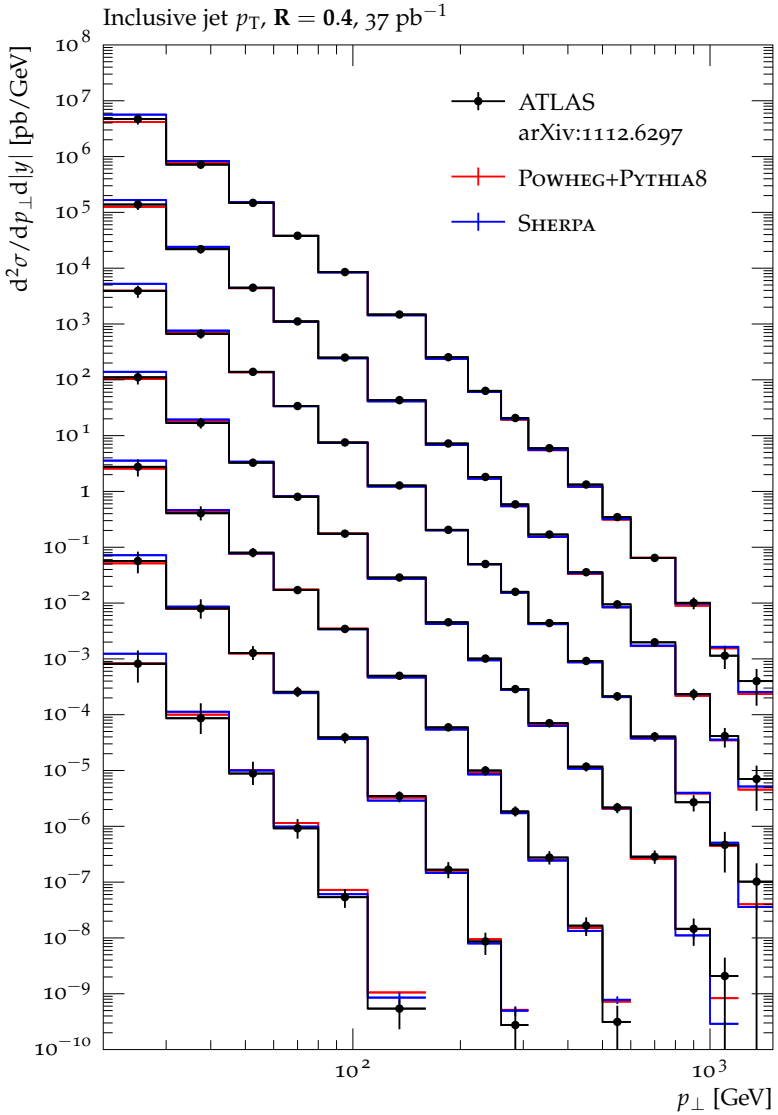
- inclusive jets
  - arXiv:1410.8857 ($4.5\ \text{fb}^{-1}$, $R = 0.4, 0.6$, $p_\text{T} > 100\,\text{GeV}$, $|y| < 3$)
  - arXiv:1112.6297 ($37\ \text{pb}^{-1}$, $R = 0.4, 0.6$, $p_\text{T} > 20\,\text{GeV}$, $|y| < 4.4$)
- dijets
  - arXiv:1312.3524 ($4.5\ \text{fb}^{-1}$, $R = 0.4, 0.6$, $p_\text{T} > 100/50\,\text{GeV}$, $|y| < 3$)
  - arXiv:1112.6297 ($37\ \text{pb}^{-1}$, $R = 0.4, 0.6$, $p_\text{T} > 30/20\,\text{GeV}$, $|y| < 4.4$)
- *b*-jets
  - arXiv:1109.6833 ($34\ \text{pb}^{-1}$, $R = 0.4$, $p_\text{T} > 20\,\text{GeV}$, $|y| < 2.1$)

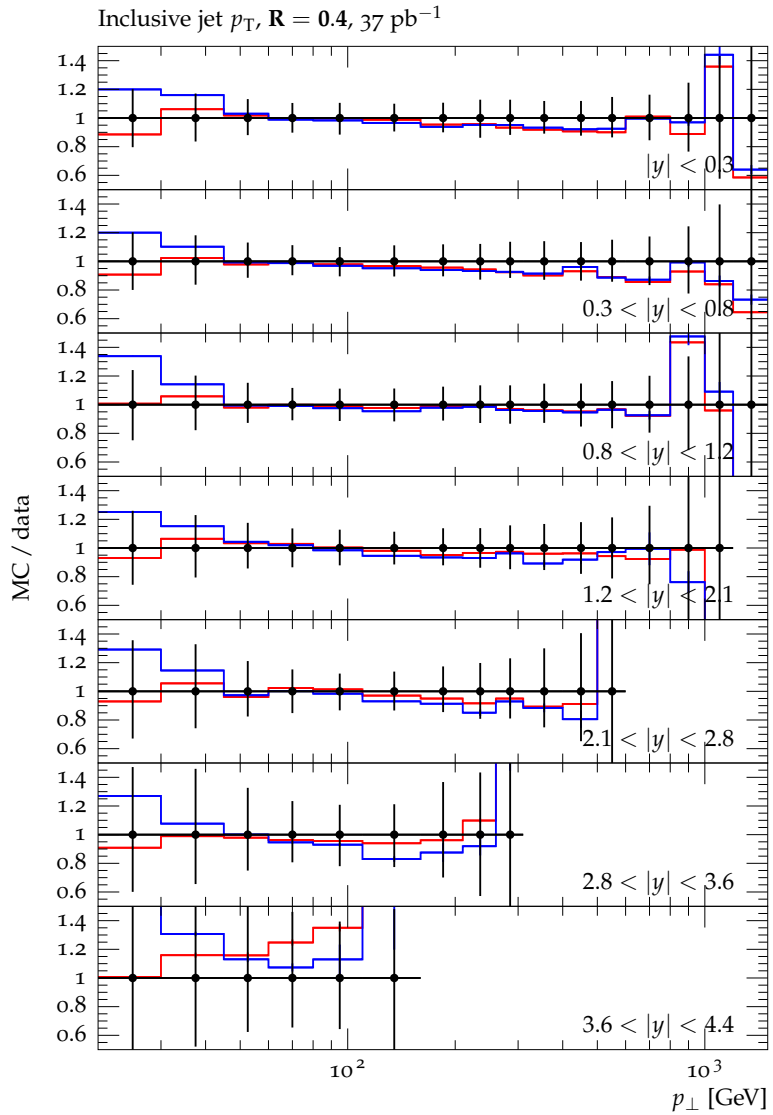
CMS

- inclusive jets
  - arXiv:1212.6660 ($5\ \text{fb}^{-1}$, $R = 0.7$, $p_\text{T} > 110\,\text{GeV}$, $|y| < 2.5$)
  - arXiv:1106.0208 ($34\ \text{pb}^{-1}$, $R = 0.5$, $p_\text{T} > 18\,\text{GeV}$, $|y| < 3$)
- dijets
  - arXiv:1212.6660 ($5\ \text{fb}^{-1}$, $R = 0.7$, $p_\text{T} > 60/30\,\text{GeV}$, $|y| < 2.5$)
- *b*-jets
  - arXiv:1202.4617 ($34\ \text{pb}^{-1}$, $R = 0.5$, $p_\text{T} > 18\,\text{GeV}$, $|y| < 2.4$)

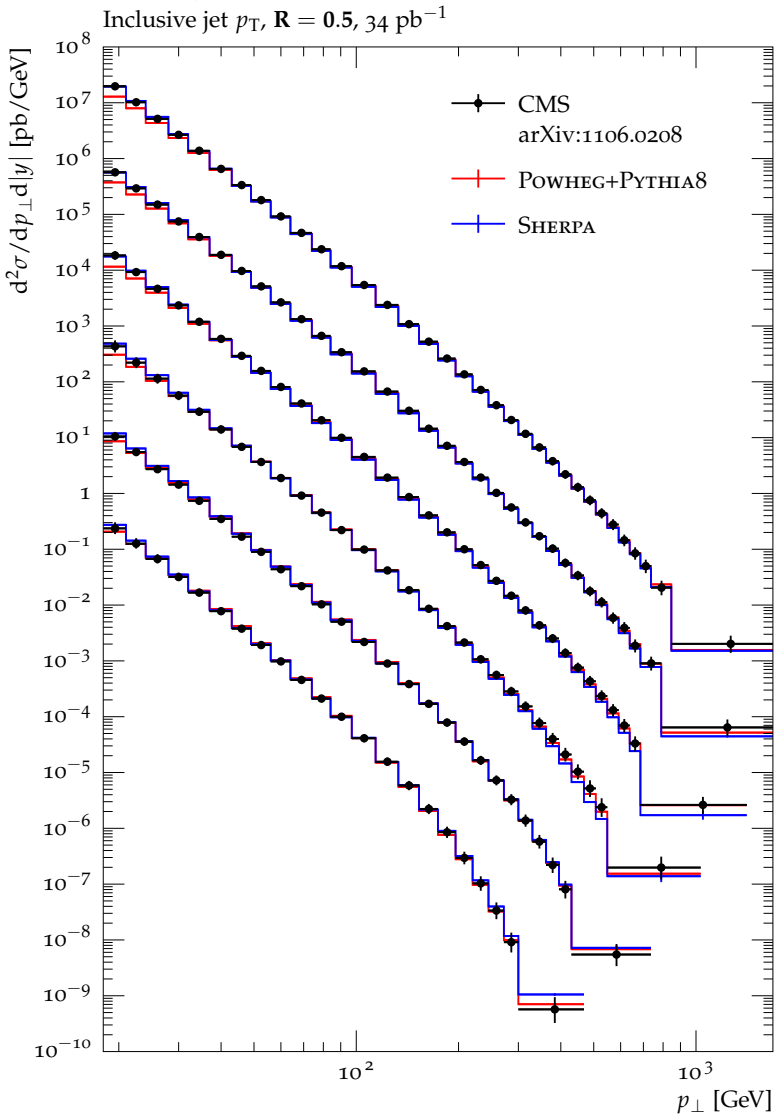
Full set of analyses and RIVET routines here.

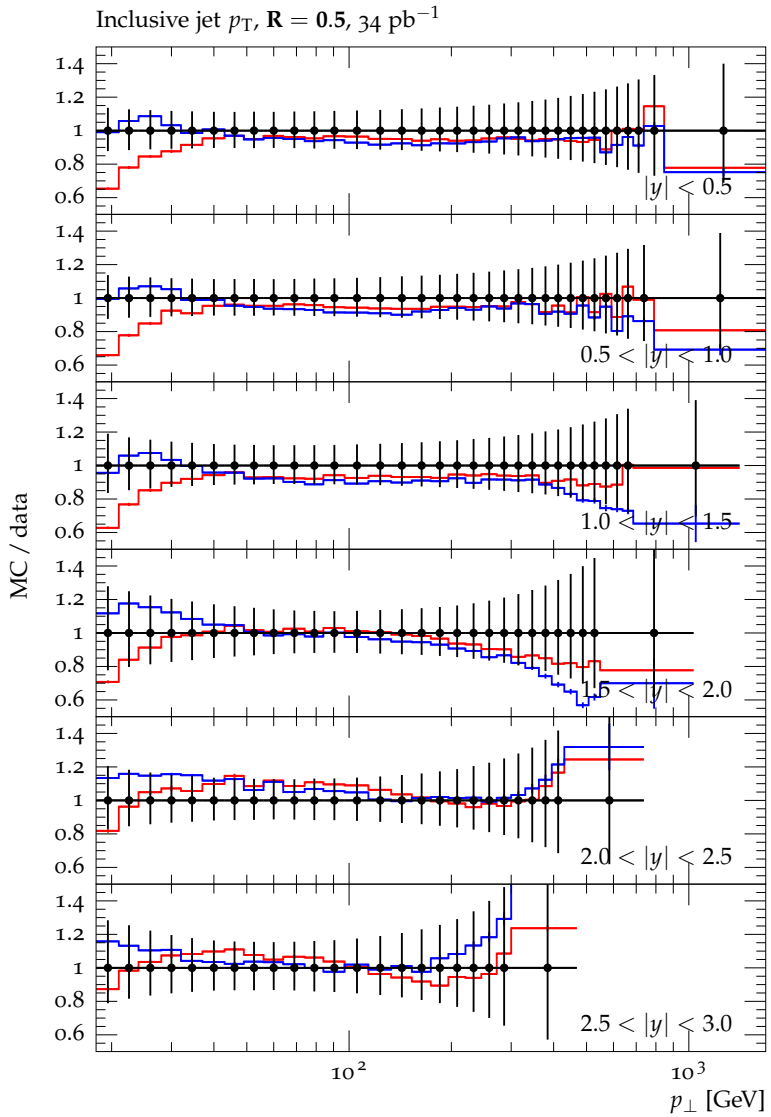
Inclusive jets



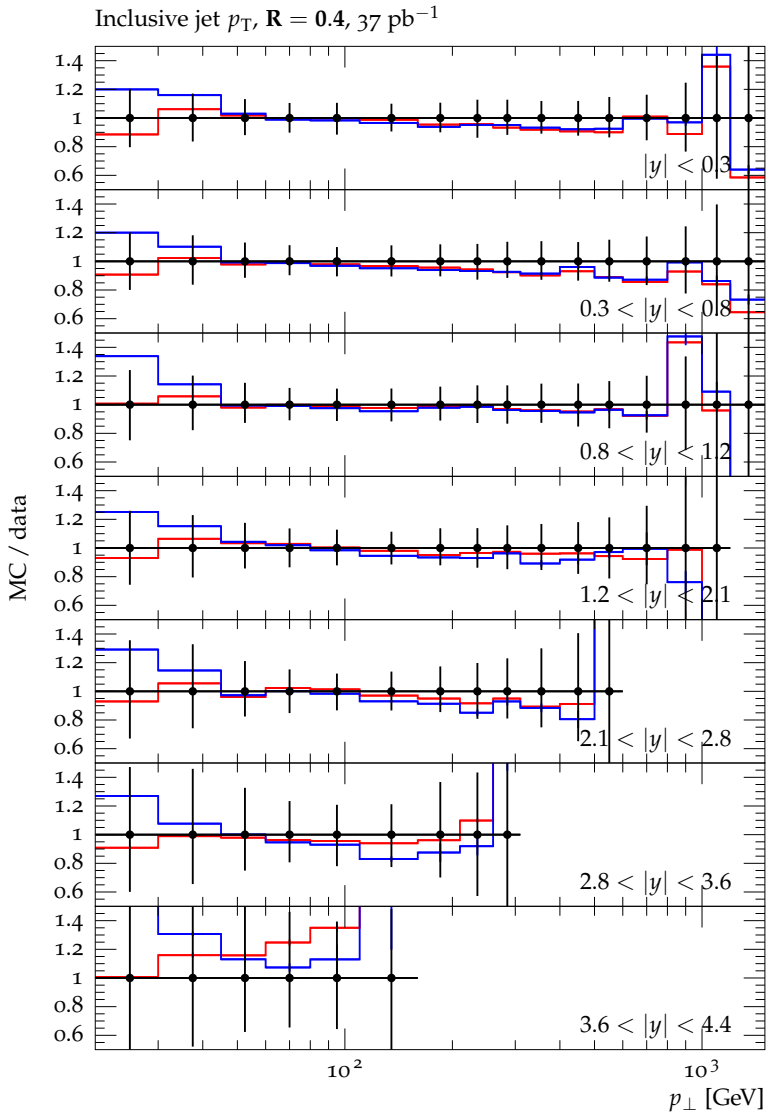


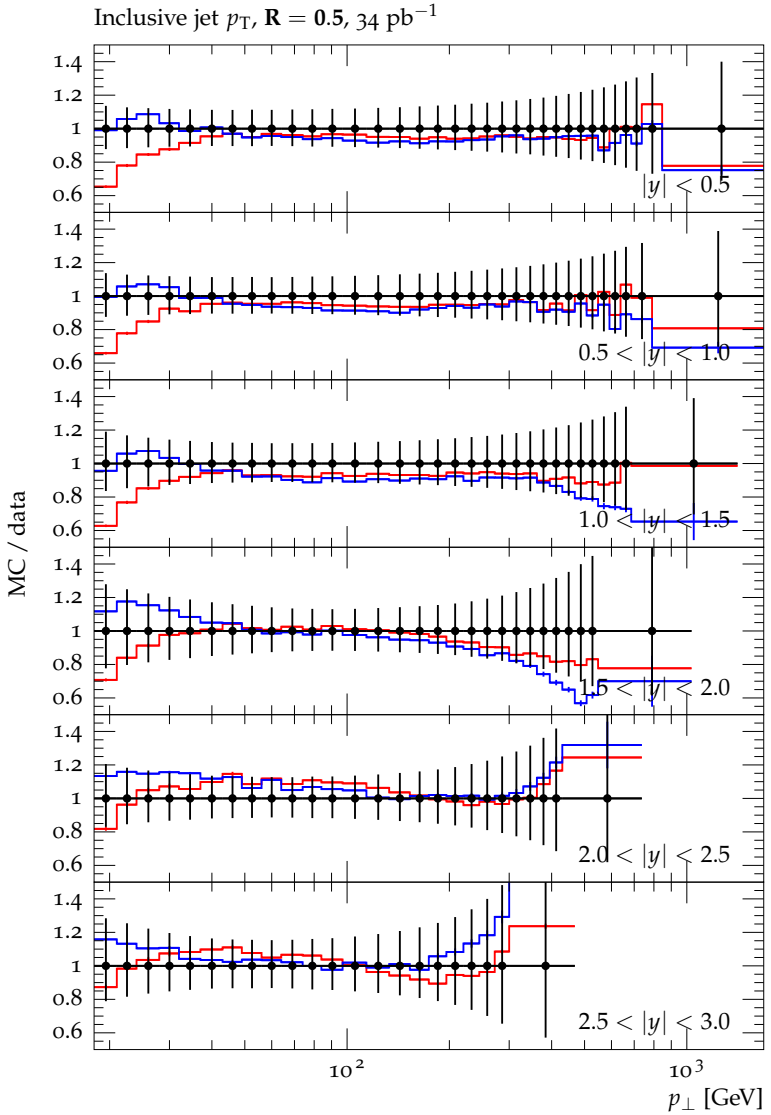
Inclusive jets



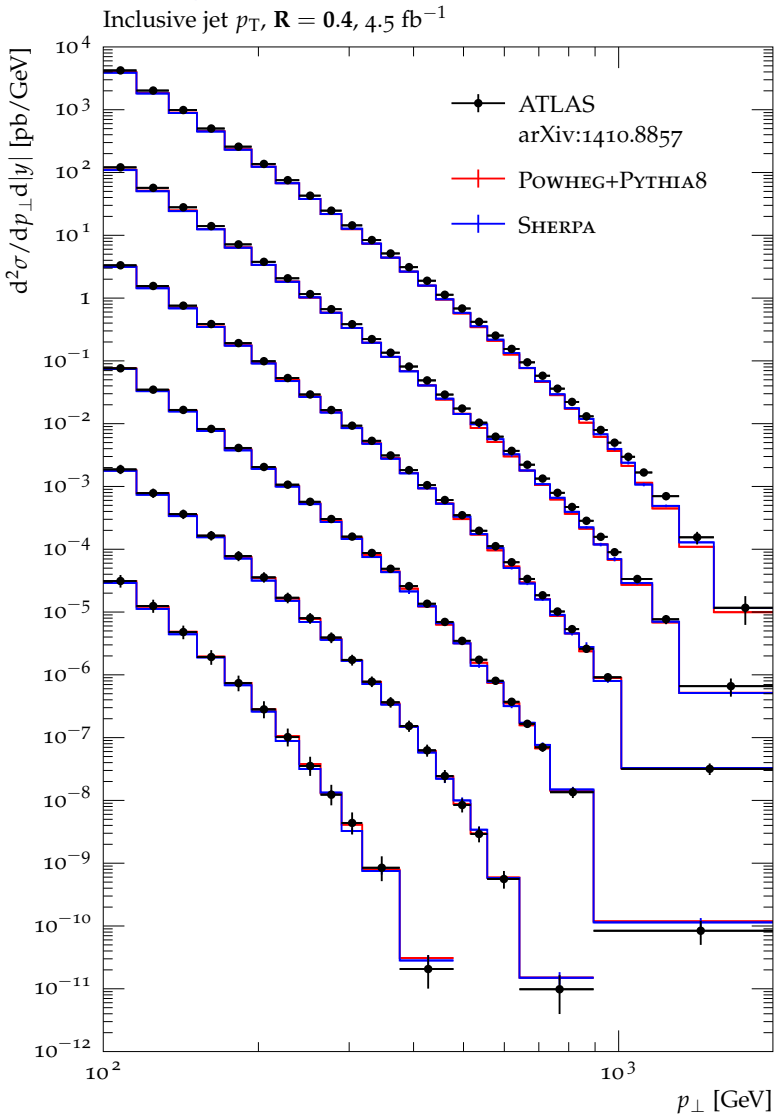


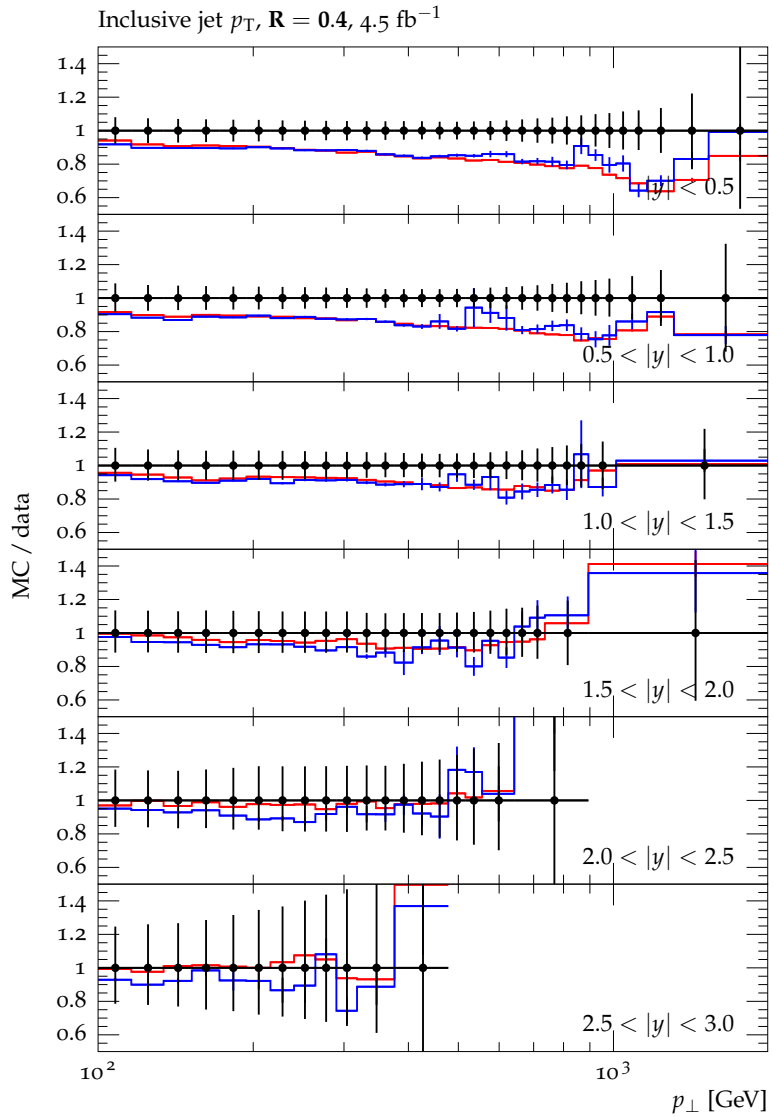
Inclusive jets



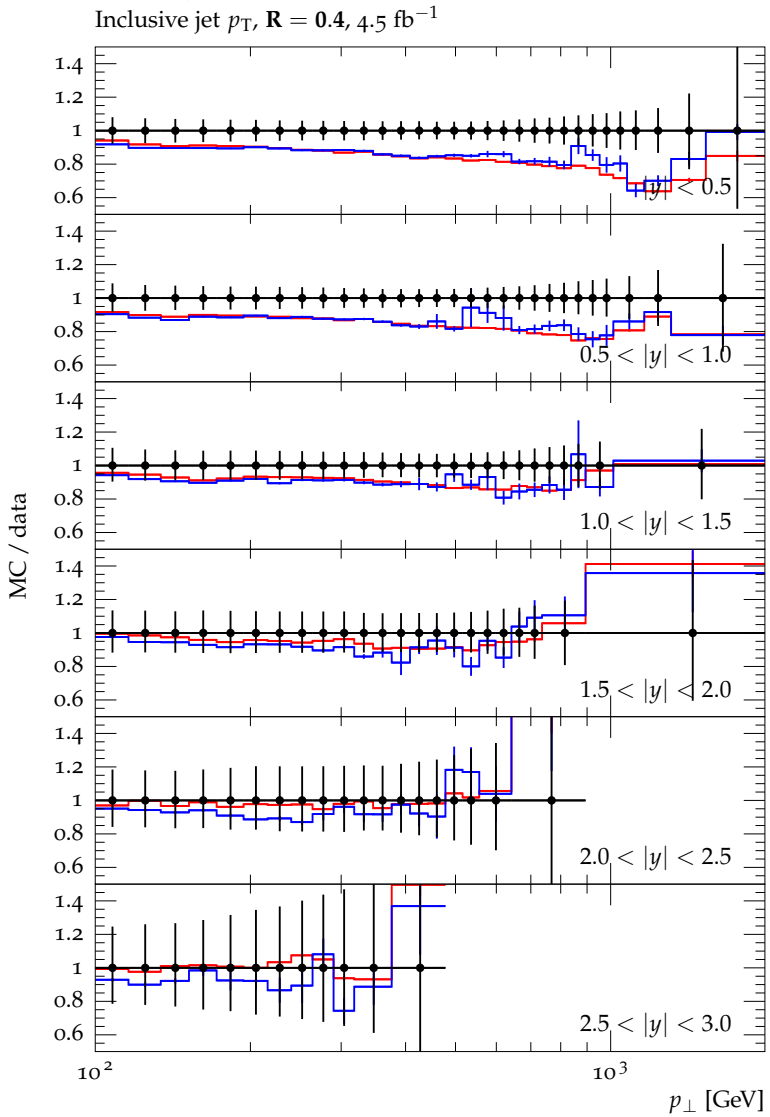


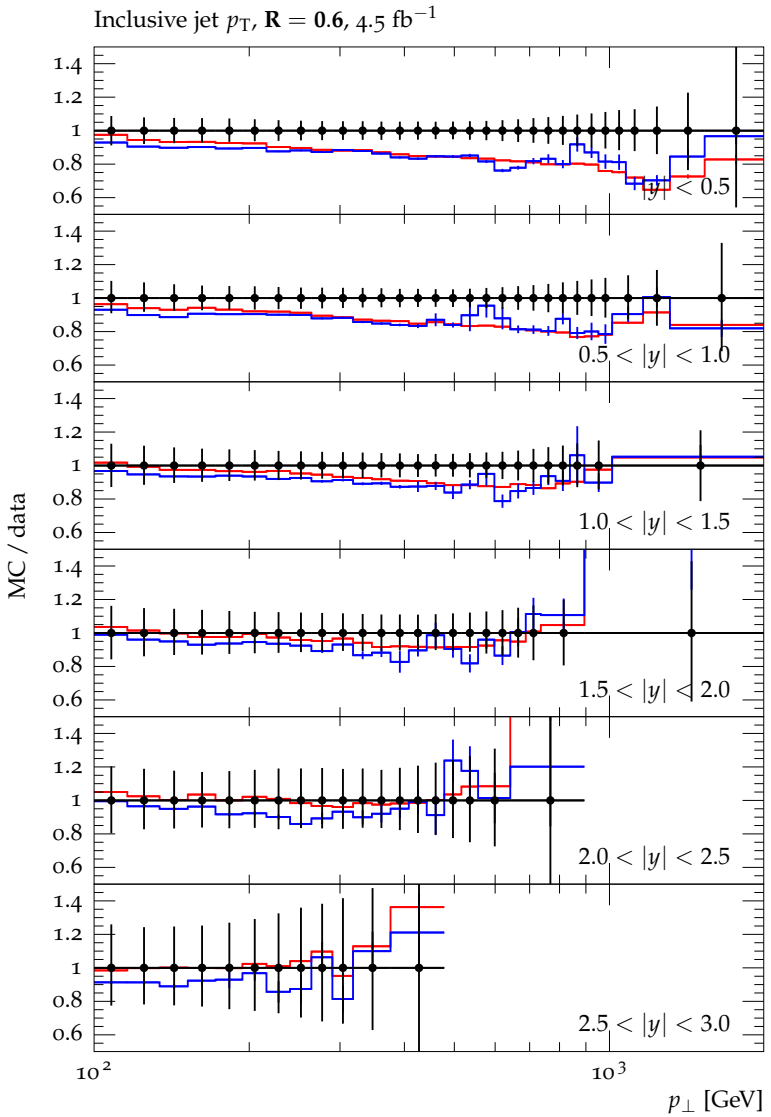
Inclusive jets



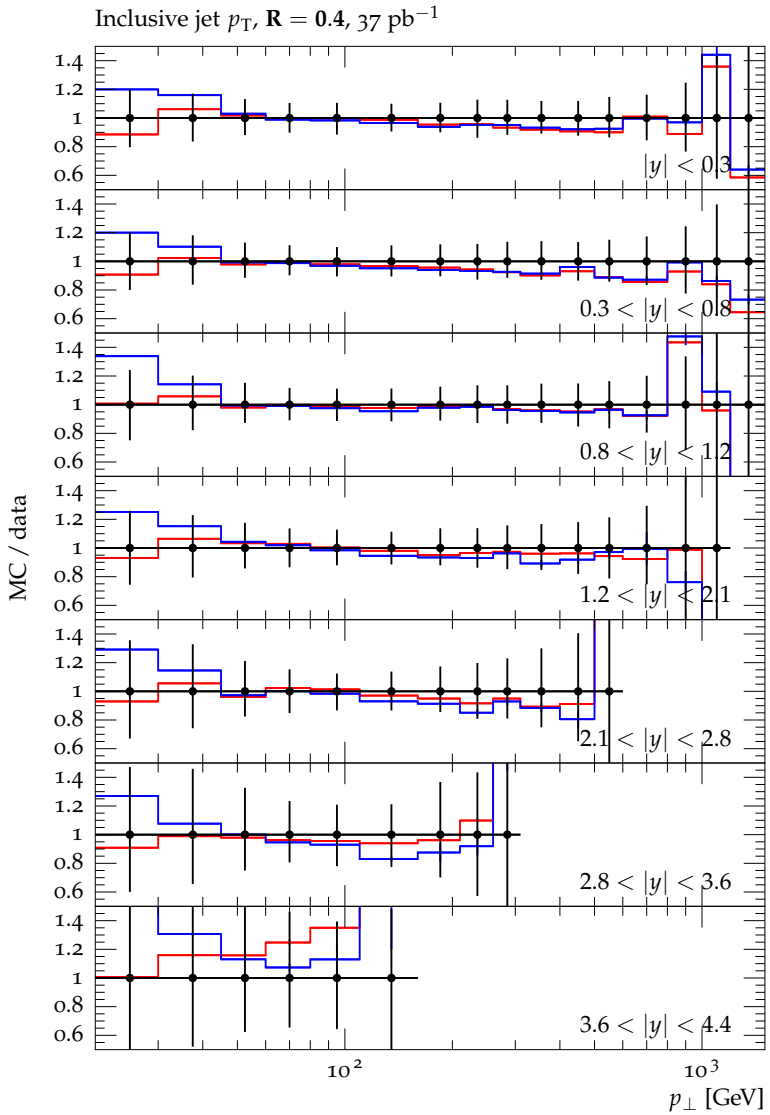


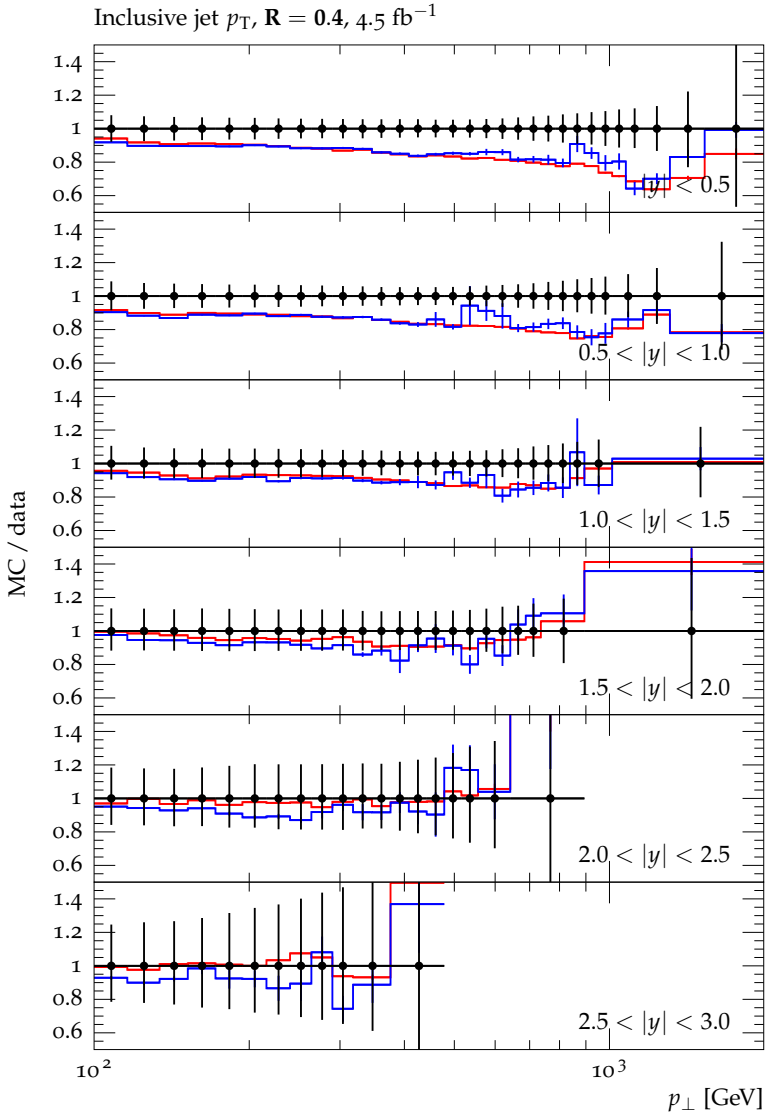
Inclusive jets



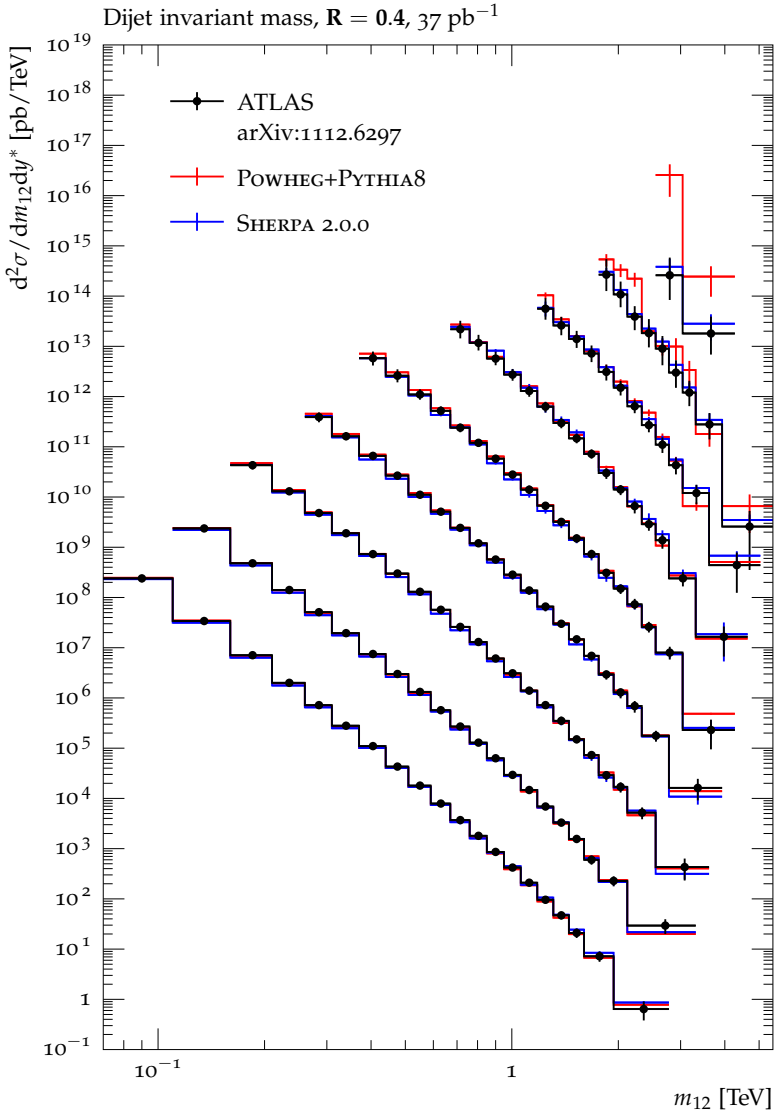


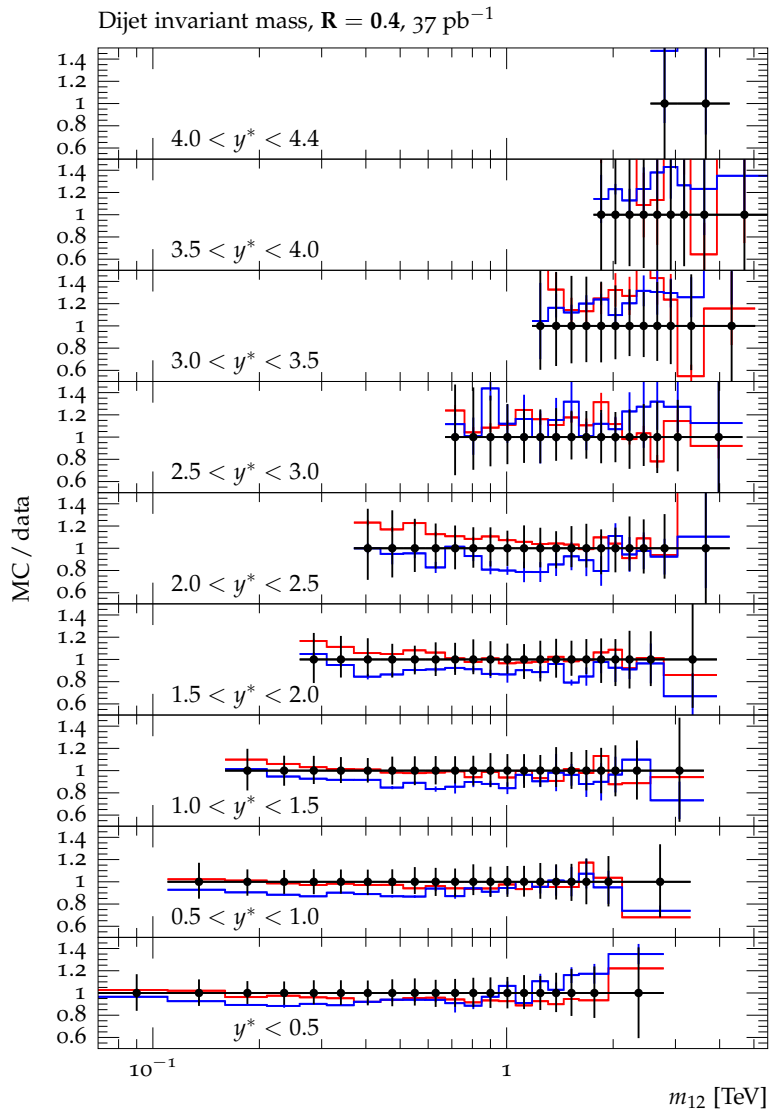
Inclusive jets



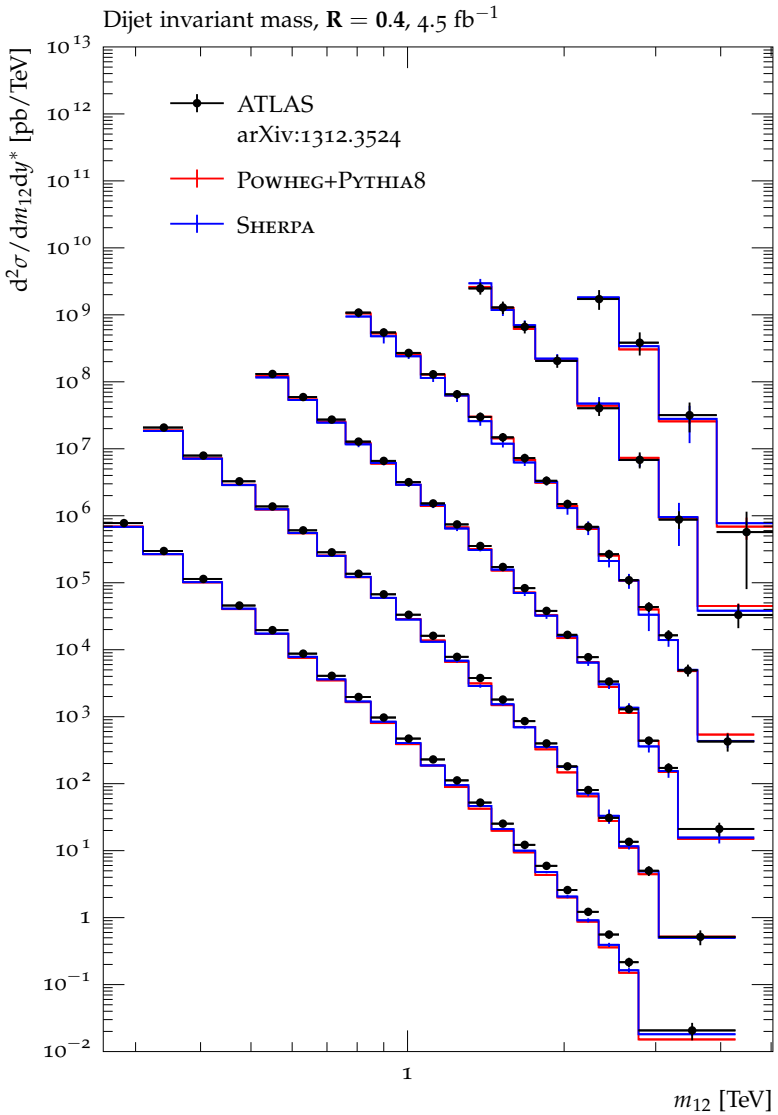


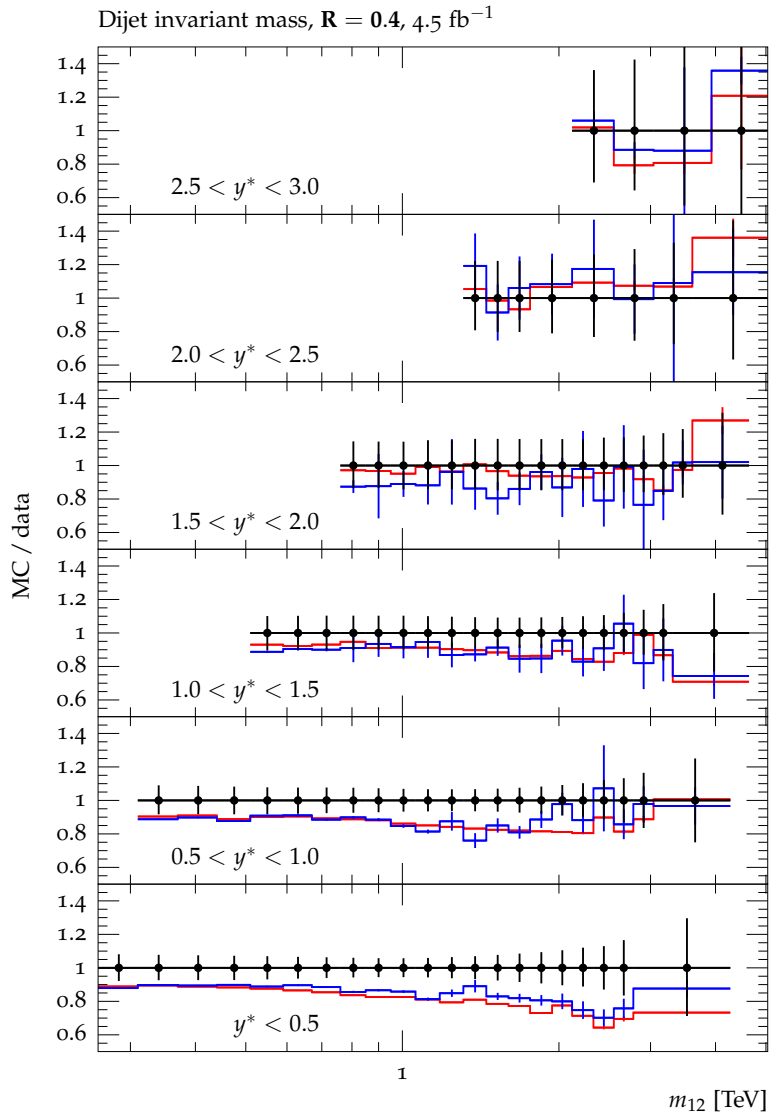
Dijets


Dijet invariant mass, R = 0.4, 37 pb^{-1}
ATLAS
arXiv:1112.6297
Powheg+Pythia8
Sherpa 2.0.0
$d^2\sigma/dm_{12}dy^*$ [pb/TeV]
m_{12} [TeV]

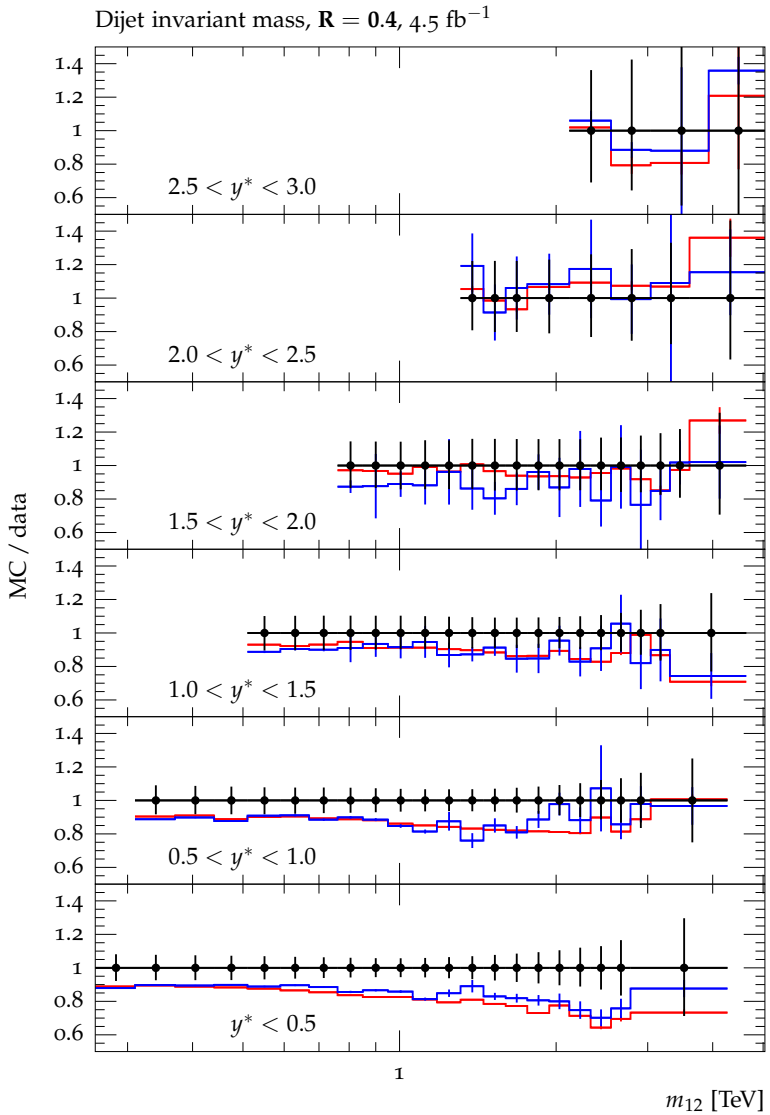

Dijet invariant mass, R = 0.4, 37 pb^{-1}
$4.0 < y^* < 4.4$
$3.5 < y^* < 4.0$
$3.0 < y^* < 3.5$
$2.5 < y^* < 3.0$
$2.0 < y^* < 2.5$
$1.5 < y^* < 2.0$
$1.0 < y^* < 1.5$
$0.5 < y^* < 1.0$
$y^* < 0.5$
MC / data
m_{12} [TeV]

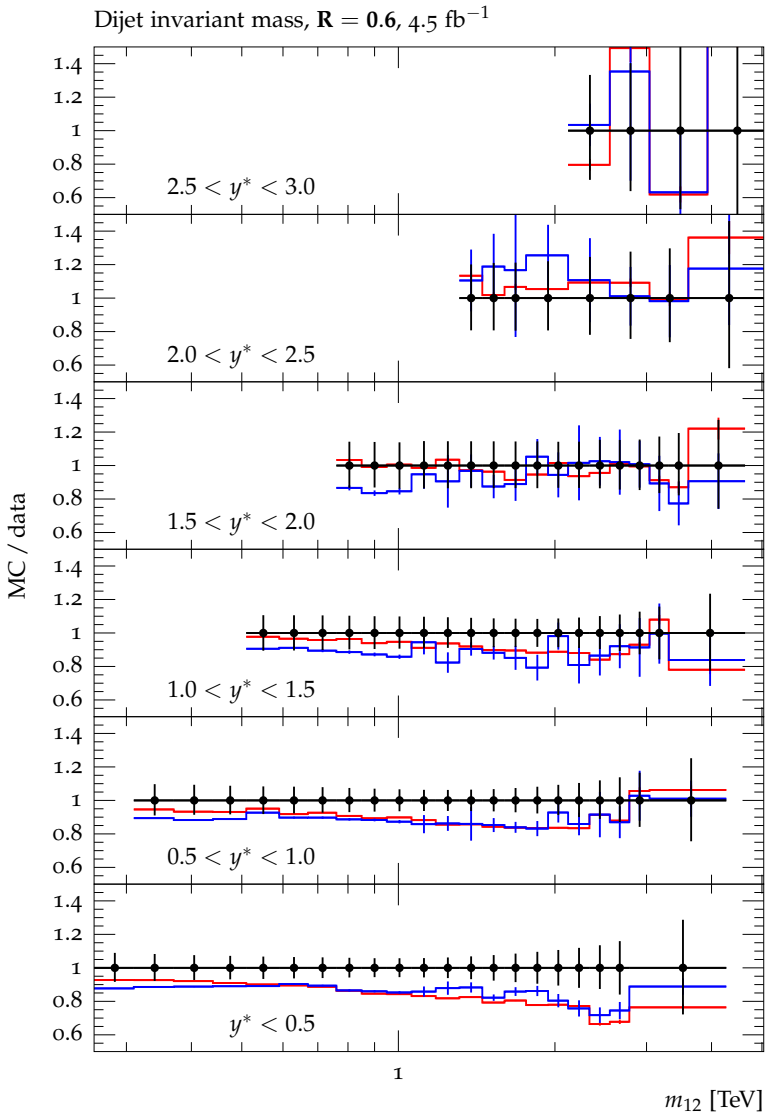
Dijets


Dijet invariant mass, R = 0.4, 4.5 fb^{-1}
ATLAS
arXiv:1312.3524
Powheg+Pythia8
Sherpa
$d^2\sigma/dm_{12}dy^*$ [pb/TeV]
m_{12} [TeV]


Dijet invariant mass, R = 0.4, 4.5 fb^{-1}
$2.5 < y^* < 3.0$
$2.0 < y^* < 2.5$
$1.5 < y^* < 2.0$
$1.0 < y^* < 1.5$
$0.5 < y^* < 1.0$
$y^* < 0.5$
MC / data
m_{12} [TeV]

Dijets


Dijet invariant mass, R = 0.4, 4.5 fb^{-1}
MC / data
$2.5 < y^* < 3.0$
$2.0 < y^* < 2.5$
$1.5 < y^* < 2.0$
$1.0 < y^* < 1.5$
$0.5 < y^* < 1.0$
$y^* < 0.5$
m_{12} [TeV]


Dijet invariant mass, R = 0.6, 4.5 fb^{-1}
MC / data
$2.5 < y^* < 3.0$
$2.0 < y^* < 2.5$
$1.5 < y^* < 2.0$
$1.0 < y^* < 1.5$
$0.5 < y^* < 1.0$
$y^* < 0.5$
m_{12} [TeV]

Conclusions

- Monte-Carlo calculations used as transfer function to compare consistency of different measurements
  $\Rightarrow$ **since different measurements use different fiducial phase space definitions, differences in description of different measurements may also stem from different levels of mismodelling in different phase space regions**
- ATLAS and CMS measurements seem consistent for inclusive jet p_{T} and dijet invariant mass spectra for low lumonisity data
- systematic differences in ATLAS data between 37 pb^{-1} and 4.5 fb^{-1}, independent of jet radius
- b-jet data also seems consistent between ATLAS and CMS
- repeat for 8 & 13 TeV data, and for V + jets
  (not all data public, not all published analyses available in RIVET)
- include LHCb data
- make reference event samples available (rely on experiments for storage space)

Reference setups and results in the CERN gitlab.

Backup

POWHEG+PYTHIA8 settings

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bornsuppfact 600d0 !  default 0d0
withnegweights 1 !  default 0
facscfact 1 !  default 1
renscfact 1 !  default 1
doublefsr 1 !  default 0
```

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POWHEG:vetoCount = 3
POWHEG:pThard = 2
POWHEG:pTemt = 0
POWHEG:emitted = 0
POWHEG:pTdef = 1
POWHEG:MPIveto = 0
ParticleDecays:limitTau0 = on
Tune:ee = 7 !  Monash 2013 tune
Tune:pp = 14 !  Monash 2013 tune
tune CUETp8M1:  CMS tune based on
NNPDF2.1LO
```